DOCUMENT RESUME

ED 159 005 SE 024 749

TITLE Forest Pest Control. Manual 94.
INSTITUTION Missouri Univ., Columbia. Agricultural Experiment Station.; Missouri Univ., Columbia. Extension Div.
PUB DATE [77]
NOTE 32p.; For related documents, see SE 024 748-751 and SE 024 665-671

EDRS PRICE MF-$0.83 HC-$2.06 Plus Postage.
DESCRIPTORS *Certification; Disease Control; Environment; *Forestry; *Instructional Materials; *Pesticides; *Post Secondary Education; Safety; *Units of Study; Weeds
IDENTIFIERS *Missouri

ABSTRACT

This training manual provides information needed to meet the minimum EPA standards for certification as a commercial applicator of pesticides in forest pest control. The text discusses disease problems, insects, and herbicide use in both established forests and nurseries. (CS)

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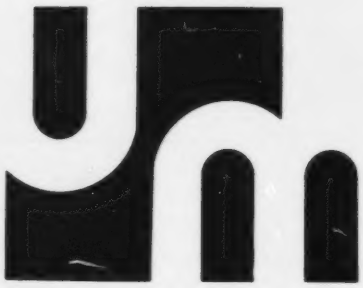

FOREST PEST CONTROL

manual 94

This manual was developed in cooperation with The Missouri Department of Agriculture and the Coop Extension Service, University of Missouri.

Assembled by Members of Extension Pesticide Training Team.

SE 024 749

Table of Contents

INTRODUCTION

Statements involving Diseases, Insects and Weeds
Refer to Core Manual--special sections of General Standards

DEFINITIONS

Forest Diseases
Forest Insects
Undesirable Forest Plants

ESTABLISHED FORESTS

Disease problems
Insects
Herbicide use

NURSERIES

Disease problems
Insect problems
Herbicide use

REFERENCE AND SUPPLEMENTAL STUDY MATERIALS

Core Manuals
Guides
Other publications

FOREST PESTICIDE APPLICATION

INTRODUCTION

In general, native forest stands have a relatively low value per unit of area so that expenditures of labor and materials on them must be relatively small. This means that intensive methods of pest control, such as cultivation, irrigation, fertilization, crop rotation, spraying, and dusting with pesticides, are rarely applicable. But in forest nurseries where value is high for a small area, intensive measures, including pesticide control, are often necessary.

Various pesticides are being used extensively in the different phases of forest pest management. Proper application is highly essential, both to gain maximum performance of the product and to minimize the possible hazards to the environment. This manual includes specific information that will enable applicators to apply forest pesticides properly, in accordance with EPA regulations. General information regarding pesticide application and use is included in the "Core Manual" which is available through the State Department of Agriculture.

DEFINITIONS

Forest Diseases.

Diseases of forest trees are caused by fungi, bacteria, viruses, mucoplasma and nematodes. Certain forest diseases are serious enough to require chemical control to prevent chronic spread of destructive epidemics. For instance, diseases such as oak wilt, Fomes annosus root and butt rot of pine, and a number of needle diseases and rusts of several evergreen species may justify certain chemical applications.

Fungicides can be used as seed treatments, foliar sprays, soil drenches, and wound dressings. When appropriately applied they can help prevent or control disease. They cannot be used instead of good management (including sanitation, fertility management and proper species selections).

On occasion some plant diseases can be exceedingly destructive. The chestnut blight fungus brought to this country from Asia literally wiped out this species, which at one time dominated the great eastern forests of the United States. More recently, Dutch Elm Disease threatens to exterminate this majestic species, as it has been destroyed in many parts of Europe. Various plant diseases of less significance prevail in our established forests today. The use of pesticides as a means of control requires a clear understanding of the disease itself, as well as the potential performance of the pesticide.

Forest Insects.

Insects can and frequently do cause injury to forest trees. Usually the injury is not of a sufficiently serious nature in the midwestern part of the United States to warrant application of an insecticide.

Insects can injure forest trees in the following ways:

1. By chewing on the leaves, buds, fruits, twigs, roots and bark of the tree.
2. By tunnelling in the stems or actually severing the twigs and small limbs from trees.
3. By sucking sap from the leaves, flowers, fruits, stems and roots of the plant.

4. By initiating the formation of abnormal growths "galls" on various parts of plants.
5. By damaging trees during the process of egg laying.
6. By disseminating the causitive agents of plant diseases.

Nearly all forest trees and shrubs are attacked by a large number of insects. They find their food sources on roots, trunks, branches, leaves or fruit of trees and shrubs. Where an especially destructive infestation develops, control programs are highly essential. Insecticides, properly used, will provide effective control.

Undesirable Forest Plants.

Woody plants are classed as weeds if they grow where they are unwanted. Inferior trees of a desirable species and trees of inferior species should be removed from timber stands to promote better growth of desirable trees. In pastures, along roadsides, and in other areas, it is generally desirable to remove unwanted trees and brush to make way for other vegetation or for more efficient use of the area.

Before beginning a chemical woody plant eradication program, define clearly the ultimate objectives. Are all woody species to be eradicated in a conversion to grass program; are deciduous (lose their leaves in the fall) species to be removed in a conifer-release program; or are the objectives entirely different? This should be the basis for selecting the proper herbicides and techniques for successful results.

ESTABLISHED FORESTS

Diseases

Oak Wilt.

Oak wilt is caused by a fungus, Ceratocystis fagacearum, and kills thousands of valuable oaks every year. Red and black oaks are more susceptible to oak wilt than are white or bur oaks. Once in a forest area, the disease keeps up an insidious tree-to-tree spread unless checked. In any area when dead or dying red or black oaks show wilting symptoms, infection centers can be suspected.

The fungus invades the water-conducting vessels of the sapwood through fresh wounds, through insects or by root grafts connecting diseased and healthy trees. Bark beetles and other insects spread oak wilt by carrying fungus spores produced on fungus mats formed under the bark of infected trees to fresh wounds on the branches of healthy trees. Infections often occur in the spring or early summer.

When infected certain cells develop projections known as "tyloses" that plug vessels and disrupt sap flow that causes wilting. Leaves at the top of the tree or toward the tips of lateral branches usually wilt first. Curling or yellowing appear first at edges of leaves and progress toward the base. Leaves later turn brown or bronze. Lower branches are the last affected. Defoliation occurs in a few weeks. If the bark is peeled back on an infected branch, the applicator can see a brown discoloration in the water conducting tissues.

Control depends upon preventing further spread when infected trees are positively identified. There is no cure for infected trees. Control measures include preventing unnecessary wounding of oak trees, prompt treatment of wounds during the susceptible season, severing root grafts either mechanically or chemically and destroying and removing infected trees.

When limbs or branches are trimmed, coat the wounded area with orange shellac and then with asphalt base paint. Prune oaks carefully and mainly during winter or late fall.

Prevent root transmission either mechanically with trenching equipment or with a soil fumigant such as SMDC (Vapam or VPM). Sever the lateral roots between diseased trees and adjacent healthy trees. As a precaution, a second trench or series of holes should be dug around the area enclosing seemingly healthy trees nearest the infected oak. For fumigant treatment, drill a series of holes about one inch in diameter, three feet deep and eight inches apart. A crowbar may be used in light soils, but power drills may be used in heavier soils. Mix one part of fumigant with nine parts of water, and pour about one cup (200 ml.) of the mixture into each hole. Cover the top of the hole with soil and tamp it shut to seal in the chemical. The soil should be about 60 to 90° F for effective action.

Destroy and remove diseased trees by girdling as soon as positively identified. Apply 2, 4, 5-T at 4 lb/gal. oil to a deep girdle in the trunk and ax cuts in roots before 50% wilt develops. Remove tree when killed, but wait until winter to prevent fresh injuries to surrounding trees. Limits: 2, 4, 5-T is restricted from use around recreational areas, ponds, ditch banks, or around homes.

Positive identification can be made only in a diagnostic laboratory equipped to culture and identify the fungus. Pieces of wood six to ten inches long and at least one-half inch in diameter, cut from wilting but living branches should be sent in to a laboratory for positive identification. However, measures to isolate the disease by the recommended procedures above should not be delayed if the typical oak wilt symptoms are encountered.

Fomes Root and Butt Rot.

Fomes root and butt rot caused by the fungus, Fomes annosus, is a widespread disease on pines and other conifers and occasionally on hardwoods. Red pine is highly susceptible. The fungus kills young trees by decaying the bark and wood of the roots and root collar. Older trees are more resistant. Injury to older trees is mostly butt rot of the heartwood that can sometimes cause heavy losses.

Symptoms in killed young trees are the thin, tissuepaper-like mycelium felts, not noticeably veined, which form between bark and wood. Also, small dirty-white outgrowths on the underside of the roots may be seen. Depending on the species of the tree, decayed wood may have a pinkish to dull-violet color. Elongated pockets of spongy or stringy white fibers

flecked with black may occur in infected wood. Resin flow may occur from the butt. Conks usually develop on the crotches of the root collar, partially hidden by litter, or even on roots abutting on cavities in the root.

Spores from conks are wind borne and infect recently cut stumps. The decay progresses from the stump into the roots. The roots of adjacent living trees are infected by contact with a decayed root and through root grafts. The fungus also can penetrate wounded bark.

Control measures include wider spacing of trees to reduce root contacts; delayed thinning because conifers become more resistant with age; stump extraction (which is difficult and costly); and application of borax (97% powdered) to freshly cut stumps.

Needle Cast.

Needle cast of most pine species is caused by several different but closely related fungus species. This disease of conifers is widespread. It occurs on pines, spruce, firs, larches and various cedars, although cedars usually suffer little or no injury.

Needle cast is most serious when young needles, particularly on young trees, are affected. Defoliation is rarely severe enough to kill any trees except young seedlings. However, young trees may be markedly weakened by continued attack. Partial to heavy defoliation may occur on many trees when the disease becomes epidemic.

The symptom most readily observed is a red or brown discoloration of the foliage, which later may turn to gray. Frequently the lower limbs are affected. Needles have spotted areas, and sometimes have glossy black fruiting structures.

Control. No control measures are known for needle cast under forest conditions.

Most fungicide control measures are directed at conifers in nurseries.

Blister Rusts of Pines.

Blister rusts of pines are caused by rust fungi belonging to the genus Cronartium. They are widely distributed, particularly attacking pines. Blister rusts are destructive, especially to seedlings, saplings, and small poles, either killing trees out right, causing malformations that make unsatisfactory timber, or severely reducing growth. Perhaps the best known of these rusts is the white pine blister rust, Cronartium ribicola.

Blister rusts are characterized by the presence of globose, subglobose, or spindle-shaped swellings or galls, depending on the particular rust. Small stems may be killed rapidly by the galls, larger ones more slowly. Infections on the trunk may cause death of the entire tree, or the top.

The blister rusts have a complicated disease cycle, including a secondary deciduous host. In order to complete the disease cycle, both hosts must be present, usually within one-half mile. For instance, the white pine blister rust is dependent on two groups of hosts for its existence. The alternate hosts

are currants and gooseberries, termed "ribes" for convenience. Spread of the disease is as much correlated with the prevalence and susceptibility of the "ribes" as with the susceptibility of pines. Damage by blister rust is also proportional to the number and susceptibility of ribes within and around a stand of pine.

In unprotected areas, the disease increases slowly at first and then rapidly. Consequently a white pine stand where blister rust is epidemic may appear little affected for many years, when judging only the larger trees. However, the more susceptible seedlings and small saplings may be almost completely absent. Stand perpetuation can become a serious problem.

Control of white pine blister rust is based on the removal of ribes in areas of pine forests. The removal of ribes from within and around white pine stands for a distance of as little as 900 feet under certain local conditions can be successful in preventing further infection.

Hand pulling or grubbing are principal methods of ribes removal. Make sure that all root systems are removed and also prevent new sprouts. In addition, the use of a mixture of 2, 4-D and 2, 4, 5-T has been successful in destroying ribes.

The antibiotic fungicide cycloheximide (e.g. Acti-dione BR for blister rust) has been used on relatively large scale in certain pine growing areas. Trees are sprayed individually with a mist-type sprayer. The anti-biotic persists in the bark and helps to prevent blister rust infection.

INSECT PESTS OF FORESTS

Insect Defoliators in Established Forests

Insects have been responsible for the complete defoliation of forest trees in certain areas in the midwestern states in the past, and in all probability will cause similar defoliation in the years ahead. Forest trees in select locations can withstand complete defoliation for two or three years in succession, providing the defoliation takes place late in the growing season, eg., late August or September. By late summer or early fall, trees have completed most of their growth for the year and have set leaf and flower buds for the following season. If complete defoliation occurs for three or four consecutive seasons, even if it occurs late in the year, there is a good chance that some limbs will die and that tree growth will decrease. (See Picture Sheet No. 3)

Defoliation of trees either by insects or other means early in the growing season can and frequently does cause serious damage. Following early defoliation, the trees will usually develop new foliage (which places added stress) on the growth requirements of the trees. Only one or two years of early complete defoliation is needed to seriously affect forest trees.

Fortunately, in the Midwest, of the many leaf-feeding insects present, only a few defoliate trees early in the season. They include: the green striped mapleworm, yellow-necked caterpillar, brown headed ash sawfly, black-headed ash sawfly, walkingstick, June beetles, oak webwork, solitary oak leaf miner, cottonwood leaf beetle, elm leaf beetle, various leaf-rollers and many others.

A few defoliators should be mentioned since they attack the high value trees such as walnut, pecan and oak.

The Walnut Caterpillar (Datana integerrima Grote and Robinson). Forest trees such as walnut, hickory and pecan are readily defoliated, while oaks are occasionally attacked by the walnut caterpillar. Frequently the trees are completely defoliated during July and August. Young trees can be stunted and older trees seriously damaged when defoliation occurs in consecutive years.

They pass the winter as a dark brown pupa about one inch in length located about four to six inches below the soil surface. The adult moth, with a wing spread of from one and one-half to two inches, emerges in June and July. The wings are light brown in color with dark brown wavy lines across them. The female moth deposits the eggs in masses of 200 to 300 on the underside of leaves on the host plant. The small reddish larvae with white stripes hatch from the eggs in about two weeks and begin to feed on the leaves. The larvae feed in groups and increase in size. The entire mass moves to a spot, usually the trunk of the tree, shed their skins, then return to feed on more leaves. The mature black larvae, with long shaggy white hair, measures nearly two inches in length. Then they leave the tree, enter the soil and change to the pupae. There is only one generation in a season in the north central states.

Control: Insecticidal control measures are seldom recommended for forest plantings, but may be necessary for individual trees in the border areas as well as individual trees in nut producing groves.

A spray containing toxaphene at the rate of three pounds actual toxaphene per 100 gallons of water or methoxychlor at the rate of one pound actual per 100 gallons of water can be used.

Variable Oak Leaf Caterpillar (Heterocampa manteo (Bdldy.). This pest sometimes builds up in great numbers in Missouri and causes complete defoliation of oak trees for two or three consecutive years. Defoliation usually occurs in late August and early September, so serious damage to plants is usually minimal. When this insect defoliates trees in resort areas, the loss of tourism income may be sufficient to warrant controls to preserve foliage.

The moth is ash gray with a wing spread of one and one-half to one and three-fourths inches. The wings vary from light gray to dark gray with darker shading.

They deposit eggs in clusters on the under side of leaves of oaks, as well as basswood and birch. The larvae vary in color. The body is smooth yellowish green with a pale, mid-dorsal longitudinal line and usually has reddish brown markings on the sides which are commonly bordered by creamy-yellow stripes. The full grown larvae are about one and one-half inches long. The mature larvae drop from the trees, enter the soil and remain over winter. Some larvae may remain in the soil for two years. Pupation takes place in July.

Control: If control becomes necessary, spray with three pounds actual toxaphene or one pound actual methoxychlor per 100 gallons of water.

Fall Webworm (Hyphantria cunea). The unsightly webs of this forest pest cause much concern when they appear in rather large numbers on cherry, walnut, pecan, hickory, apple and persimmon late in summer. Although the webs may be numerous and defoliation moderate to severe, actual damage to the infested trees is of little importance.

The insect passes the winter as a dark brown pupae in flimsy cocoons under trash on the forest floor and under loose bark. The white moths with a wingspan of about one and one-fourth inches begin to emerge in late May. Emergence continues for about a month. Clusters of eggs are deposited on the leaves of trees. The larvae, or caterpillars, are pale yellow, black spotted and very hairy. They measure about one inch long when mature. They feed on leaves enclosed in the large webs. There are two generations of the pest in most of the central area of the midwest.

Borers in Established Forests

Several insects bore into the stems, roots, and twigs of forest trees. The bronze birch borer, ash borer, carpenterworm, oak timberworm, poplar borer, locust borer, redheaded ash borer and others are examples of insects that cause this type damage. Some of these insects will attack healthy trees, while others attack only dead or dying trees. Trees damaged by fire, winter injury, ice, winds, defoliating insects and disease are frequently attacked by these borers. It is seldom a paying proposition to apply insecticides to control these insects. Usually the borers are inside the trees and therefore cannot be controlled by applying insecticides in the more economical ways. The removal

of seriously damaged as well as dead and dying trees, is the best method of keeping these pests under control.

Carpenter Worm (Prionoxystus robiniae (Peck). The larval form of this insect will attack the heartwood and large limbs of oaks in the red and black oak groups, locust, poplar, ash, willow and other forest trees. The larvae overwinter in their tunnels in the trees. Since the insect apparently takes three years to complete its life cycle, the borers vary in size from three-fourths to two inches in length. The larvae are white, tinged with pink. They have shiny black heads and have raised dark bumps over their bodies. Pupation takes place in the tunnels but the pupae work their way toward the bark of the tree. Moth coloring depends on the sex. The females are generally gray with black markings and a wing expanse of three inches or more. The males are generally smaller ranging from a two to three-inch wing span, with the hind wing bordered with orange. Eggs are deposited in crevices in the back of host trees and the larvae, upon hatching bore into the wood.

Trees attacked by this pest are weakened and sometimes break over in high winds. Carpenter ants use the empty tunnels for their nest site. Lumber from damaged trees may be severely down graded.

Control: Control of this pest is not practical.

Sap Sucking Insects in Established Forests

Insects such as scales, aphids, leafhoppers and plant bugs with piercing sucking mouthparts suck the sap from trees but seldom become a serious problem in established hardwood forests.

Insect Galls in Established Forests

Many diverse groups of insects begin the formation of galls on forest trees while others damage parts of trees when they insert eggs into stems and limbs. These insects seldom cause economic damage in well managed forests.

Insects as Disseminators of Plant Diseases

Insects, including some bark beetles and borers, do transmit diseases such as Dutch elm disease in elms and oak wilt in the various species of oak trees. It is not practical nor economical to spray forests to control these pests. Proper forest management is the only practical method for salvaging forest products from the diseased trees. Prompt removal of these diseased trees is essential.

HERBICIDE UTILIZATION IN ESTABLISHED FORESTS

Herbicides for woody plant control have received widespread acceptance during the past several years. Herbicides are effective, safe to use, relatively economical, and easily applied.

Description of Herbicides

Phenoxy Compounds. The phenoxy herbicides include 2,4-D; 2,4,5-T; and silvex (2,4,5-TP). Although these compounds are closely related, they vary considerably in effectiveness for controlling woody plants. For example, osage orange (Maclura pomifera) is resistant to 2,4-D but susceptible to 2,4,5-T. Silvex is somewhat more effective on certain species than the other phenoxy compounds, but is more costly and therefore is not as widely used. The 2,4-D and 2,4,5-T herbicides can be applied in combination to control mixed populations. The phenoxy compounds are available as ester or amine formulations. (See MU Guide 4902, "Know Your 2,4-D") The ester form is more effective as a brush or tree killer than the amine.

Esters are available in high volatile and low volatile forms. High volatile esters will volatilize (evaporate) readily at 80° or above and can be carried by air currents for considerable distances, even on a still day.

Low volatile esters cost slightly more. They are made from high molecular weight alcohols, so are less likely to produce vapor drift. However, low volatile esters are not as safe to use as the amines.

Amines are safer than esters, for they cause less drift injury to sensitive crops growing next to the sprayed area. All forms of the phenoxy herbicides can injury sensitive crops or ornamental plants from drift or volatilization. They should be applied with caution and used according to label instructions.

Amitrole (Amino-Triazole) is formulated as a water soluble powder for application in solution form. It is safer to use than 2,4-D; 2,4,5-T; or silvex where drift would be injurious to nearby plants. Amitrole works on too few species to be used as a general brush killer. It is especially effective on black locust, poison ivy, poison oak, and sumac. It moves readily through the plant system so it can be applied to foliage. However, it is not absorbed through bark. Amitrole is not cleared for use in areas grazed by livestock.

Ammate (ammonium sulfamate) is a granular material, very soluble in water, that breaks down rapidly in moist soil. It is available in crystalline or liquid form. It is a non-selective contact herbicide applied as a foliage spray and is effective over a wide range of conditions and species. Ammonium sulfa mate is especially effective on poison ivy, poison oak and poison sumac. There are no grazing restrictions where ammate is applied in pasture areas.

Tordon (picloram) is available as a foliage spray or in pellet form for soil application not registered for use in pastures.

BRUSH CONTROL HERBICIDES
USE AND CHARACTERISTICS

COMMON NAME	TRADE NAME(S)	MAJOR USE	WARNINGS
Amitrole	Many	Poison Ivy	Damages all green foliage
AMS	Ammate	Foliage, stump and full brush and tree treatments	Corrosive to equipment
2,4-D	Many	Foliage spray	Damages all broadleaf plants
2,4,5-T	Many	Stump, foliage and stem sprays	Damages all broadleaf plants
2,4,5-T LV	Many	Same	Damages all broadleaf plants
2,4,5-TP	Silvex	Foliage spray	Damages all broadleaf plants
Picloram	Tordon	Foliage spray	Damages all broadleaf weeds
Picloram	Tordon	Pellets	Applied to soil over plant roots is highly effective

NOTE: Many combination mixtures are available to improve brush control. They may contain 2,4-D, 2,4,5-T, 2,4,5-T LV, and Tordon. Knowing exactly what combination you are using is vital to safety, legality of use and performance on the job.

SUSCEPTIBILITY RATING

The table lists the effects of phenoxy herbicides when applied as foliage sprays on a number of species. Normal rate of application for 2, 4-D; 2, 4, 5-T; or silvex is one pound per acre. The control ratings for the herbicides are interpreted as follows:

Excellent. One application at recommended rate kills.

Good. Several applications at recommended rate needed to kill.

Fair. Repeated applications at recommended rate or application at higher rates needed to kill.

Poor. Kill is erratic, even at high rates of application.

SUSCEPTIBILITY OF WOODY PLANTS TO FOLIAR APPLICATIONS OF 2, 4-D, 2, 4, 5-T, & SILVEX

WOODY SPECIES	CONTROL		
	2, 4-D	2, 4, 5-T	Silvex
Ash (Fraxinus spp.)	None	Poor	Poor
Blackberry (Rubus spp.)	None	Good	Fair
Boxelder (Acer Negundo)	Good	Good	Good
Buckbrush (Symphoricarpos orbiculatus)	Good	Fair	None
Western (S. Occidentalis).	Fair	Poor	----
Cedar (Red) (Juniperas Virginiana)	None	None	None
Choke Cherry (Prunus Virginiana)	Poor	Fair	Fair
Dewberry (Rubus spp.)	None	Good	Fair
Elm (Ulmus spp.)	Poor	Fair	Fair
Gooseberry, Sierra (Ribes roezli)	Excellent	Good	----

SUSCEPTIBILITY OF WOODY PLANTS - CONTINUED

WOODY SPECIES	CONTROL		
	2,4-D	2,4,5-T	Silvex
Greenbriar (Smilax Bona-Nox)	None	Poor	Poor
Gum, Black (Nyssa Sylvatica)	Poor	Fair	Fair
Gum, Sweet (Liquid-ambar Styraciflua)	Poor	Good	Fair
Hawthorn (Crataegus spp.)	None	Fair	Poor
Hickory (Carya spp.)	Poor	Fair	Fair
Honey Locust (Gleditsia triacanthos)	Poor	Fair	----
Juniper (Juniperas spp.)	None	None	None
Locust, Black (Robinia pseuda-acacia)	Fair	Good	Good
Maple (Acer spp.)	Poor	Fair	Good
Mulberry (Morus spp.)	None	Poor	Fair
Oak, Black (Quercus Veluting)	Poor	Fair	Fair
Oak, Blackjack (Q. Marilandica)	Poor	Fair	Fair
Oak, Post (Q. Stellata)	Fair	Good	Good
Oak, White (Q. alba)	Fair	Good	Fair
Osage-orange (Maclura pomifera)	Poor	Good	Fair
Persimmon (Diospyros Virginiana)	Poor	Poor	Fair
Poison-ivy (Rhus radicans)	Fair	Excellent	Excellent
Poison Oak (Rhus diversiloba)	Fair	Excellent	Excellent
Prickly-ash, Northern (Xanthoxylum americanum)	Poor	Fair	----
Raspberry (Rubus spp.)	Poor	Good	Good
Rose, Multiflora (Rosa Multiflora)	Poor	Fair	Fair
Rose, Prairie (R. pratincola)	Fair	Excellent	----
Sassafras (Sassafras varifolium)	Poor	Poor	----
Sumac (Rhus spp.)	Excellent	Excellent	----
Trumpetvine (Compsis radicans)	Fair	Fair	Good
Walnut, Black (Juglans nigra)	Excellent	Excellent	----
Willow (Salix spp.)	Good	Good	Good

PRECAUTIONS IN HERBICIDE USE

FDA STATEMENT: 2,4-D. Do not graze dairy animals on treated areas within seven days after application.

2,4,5-T. Apply when in full leaf and after grass is well established.

Silvex. Do not use on freshly seeded pastures or rangelands.

2,4,5-T. Cannot be used for brush control around the home, on lakes, ponds or ditchbanks.

Picloram. Apply in non-crop areas. Avoid drift to sensitive species, such as grapes, cotton, and various legumes. Do not allow drift to contaminate waterways.

NURSERIES

Disease Problems

Seedling Disease.

Seed decay and seedling diseases are serious problems in nurseries. Preemergence death because of seed-borne or soil-borne fungus attacks on the seed or young seedlings can sometimes be extensive in nursery beds. Post-emergence damping off can also destroy seedlings.

Control depends upon the use of fungicide seed treatment and drenches of the seed bed when needed if damping off occurs. Captan or Thiram are fungicides that can be used for seed treatment or for drenching the seed bed. For instance, when sowing conifer seeds in the spring, treat the seed with

Captan 50% or Thiram 75% at two oz/lb. Add Methocel 4% (1.0 fluid oz) or other sticker for pelleting seeding. For fall sowing, use Captan 50% or Thiram 75% at 8 oz/lb and add the Methocel 4% (3 fluid oz) or other sticker for increased protection.

Nematodes and Root-disease Complexes.

If nursery beds have been used for several years and especially if nursery stock may have been imported, parasitic nematodes and other parasitic organisms can build up. When such problems are properly identified, soil sterilization may be necessary.

Control of nematodes and root-disease fungi can be obtained by spray or fall applications of soil fumigants. Applications should be made at least two weeks before planting. Spring or fall applications can be made when soil temperatures are from 55° to 80° F.

Pre-plant application is most effective when the soil is prepared free from clods and in good seed bed condition. Introduce the nematicide into the soil and immediately cover with a gas tight plastic film. Nematicides that can be used are: Dowfume MC-33 at 350 lbs. per acre or Vorlex at 40 to 60 gal. per acre or Vapam at 1.5 gal. in 40 gal. water per 100 sq. yds.

Another method is to inject a soil fumigant chemical to a depth of 10 inches through chisels spaced 12 inches apart. Seal soil with a roller to stop the fumigant from escaping.

Post-plant application. For soil applications around established plants, Fumazone 86 or Nemagon 12.1 C (or other comparable fumigant material) can be used. Plant tolerance should be checked and application rates and methods should be selected according to tolerance; as stated in the manufacturer's instructions.

IN ALL APPLICATIONS OF SOIL FUMIGANTS MANUFACTURER'S RECOMMENDATIONS SHOULD BE FOLLOWED CAREFULLY. PROFESSIONAL ASSISTANCE IN APPLICATION MAY BE NECESSARY.

Needle Disease of Pine Trees.

Several needle diseases threaten pine tree species in nurseries and tree plantations. Nurseries for the Scotch pine trees that are used for Christmas trees should be watched closely for serious and extensive outbreaks.

Brown spot needle blight is a serious disease of Scotch pine in the north central states. The Lophodermium needle disease is also causing serious damage in Scotch pine plantations in some northern states and is a threat in nurseries. Diplodia tip blight, although more prevalent in older trees, can be a problem in nurseries. Dothistroma needle blight can cause extensive damage to Austrian and ponderosa pines in the central and southern great plains. Other needle and twig diseases may need treatment, but the former diseases are the most serious.

Early detection, disease recognition, and the cultural and chemical control measures described below are essential to avoid serious losses.

The symptoms of the various needle blights vary not only among the different fungi but also in the response among different pine species. Browning of needles as a result of infected spots is characteristic of many of the diseases. Needle death is often in the lower twigs. Young trees can turn brown and die rather rapidly.

Control of the needle diseases in tree nurseries is important to prevent the threat of serious economic losses. Appropriate and timely control measures involve both cultural practices and chemical control.

Cultural practices include: (1) disposal of infected trees, (2) removal of branches remaining on stumps to reduce infection sources, (3) shearing of trees (only in dry weather with sterilized shearing tools), (4) promptly cutting and destroying small pockets of infected trees to prevent spread, (5) selecting several varieties of trees, especially those more tolerant to needle diseases, (6) examining nursery stock before planting to make sure it is not diseased.

Chemical control with fungicides often is needed to augment the benefits of cultural practices. Fungicides with label registration for control of needle diseases are: Bordeaux mixture (8-8-100), Maneb (80% WP), Zineb, Daconil 2787 (Bravo 75% WP). Several other fungicides have been effective under experimental conditions and may have labels for evergreen species in the future.

Leaf Diseases of Deciduous Species.

Anthracnose is the name given to a fungus disease characterized by leaf spots on several tree species. Caused by several related species of fungi, the disease occurs most commonly and severely on sycamore, white oak, elm, silver and sugar maple. Other host trees - generally only slightly affected - include ash, birch, hickory, linden (basswood), tulip tree and walnut.

Anthracnose-causing fungi have similar life cycles, but require slightly different moisture and temperature conditions for infection. Since the fungi are different and the host tree species are different, symptoms also vary. Generally, the disease is characterized by circular to irregular brown spots on the leaves. In certain susceptible trees such as sycamore, twig infections may also occur, with serious consequences especially to young trees.

Anthracnose may cause defoliation of most maples, oaks, elms, walnut, birch, sycamore and hickory. Leaf loss is usually more severe following unusually cool or wet weather during the bud break stage.

Control Anthracnose and other leaf spotting diseases of trees with preventive measures that help reduce the attacks. Sanitation measures, collecting and burying or burning fallen leaves and dead twigs, are important. Pruning out infected tree parts will reduce infection potential. Pruning to increase air circulation and faster drying is also desirable.

Chemical control may be necessary if anthracnose appears to cause serious leaf injury and defoliation on a year-to-year basis. Growth of nursery trees will be substantially reduced by defoliation. Several fungicides that are registered for use by the EPA are Bordeaux mixture (copper sulfate, hydrated lime and water) and other commercial copper fungicides such as tri-basic copper sulfate and Kocide 101. Benomyl fungicide (Benlate) is also registered for anthracnose control. It also can be used specifically as a foliage spray treatment for Dutch elm disease in elm. Zineb can be used on hickory, oak and sycamore. Dodine has label for walnut anthracnose. Other labels may be pending.

Although trees vary in the onset of the anthracnose, generally the first application should be made in the spring when the leaves are half grown. A second spray should be made 10-14 days later.

Hand spraying can be used on young trees. However, larger trees require high pressure spraying equipment.

Insects

Seedling plants in forest nurseries are seldom defoliated by insect pests in the Midwest. Usually the plants are too small to be attractive to leaf-feeding insects. Also, nursery personnel work more closely with these plants during the insect season. So they can note light infestation before serious damage occurs.

Herbicide Use

In general herbicides are not used in forest nurseries.

SEED PROBLEMS

Diseases

Some of the diseases that occur in nurseries or in established forests can become a problem to seed producing areas. Identification and control measures would be someqhat similar except that larger trees may be involved.

1. Needle Diseases of Pine and Other Conifer Species
   See the description and suggestions under nurseries.
2. Leaf Diseases of Deciduous Species
   See the description and suggestions concerning anthracnose and other leaf diseases under Nurseries.

Wood Rots.

Wood rots often occur as a result of wounding, either naturally or by careless pruning. Surgically remove the rotted area before treatment. Whenever pruning operations are made use tool disinfectant dips such as denatured alcohol or formaldehyde (1.3 fl. oz. or 2.5 tbsp. of 37.5% formalin/gallon water) between cuts. Use a wound dressing compound evenly over freshly cut surfaces. Use 1.0% Thiram or 3.3 to 10.0% copper naphthanate or 2.0% sodium o-phenylphenate in an asphalt base. Other commercial tree wound preparations are available.

Insects

A few insects attack the seed of forest trees. The nut and acorn weevils (Curculio spp.) at times take a rather heavy roll of these seeds. Unless there is an area where numerous seed producers are located or only a very few scattered select seed producing trees are considered, it is seldom practical to treat the trees for insects.

Herbicides

Herbicides are not used in forest seed production.

REFERENCE AND SUPPLEMENTAL STUDY MATERIALS

Forest Diseases

Boyce, John S.
1961 Forest Pathology 3rd Edition 572 pp. McGraw-Hill Book Company, Inc. New York

Murray, B. R. and W. N. Garrett
1969 Annosus Root Rot in Planted Pine Stands. Cooperative Extension Service. University of Georgia, Athens. 8 p. illus. Circular 579

Nicholls, Thomas H. and Darroll D. Skilling
1974 Control of Lophodermiums Needlecost Disease in Nurseries and Christmas Tree Plantations North Central Forest Experiment Station St. Paul, Minn. 11 p. illus. (USDA For. Serv. Res. Pap. NC - 110.)

Nicholls, Thomas H. and H. Daniel Brown
1972 How to Identify Lophodermium and Brown Spot Diseases on Pine. North Central Forest Experiment Station. USDA Folder illus. (Distributed by State and Private Forestry Forest Service USDA Market Street Upper Darby, Pennsylvania 19082.)

Palm, Einar W. and Merton F. Brown
1973 Needle Diseases of Pine Trees Cooperative Extension Service, Department of Plant Pathology, University of Missouri, Columbia 10 p. (Mimeo. P.P.UMC.)

Palm, Einar W.
1975 Anthracnose of Shade Trees Department of Plant Pathology, University of Missouri 3 p. (M-19 P.P.UMC.)

Peterson, Glenn W. and David A. Graham
1974 Dothistronia Needle Blight of Pines Rocky Mt. Forest and Range Experiment Station, Lincoln, Neb. 5 p. illus. (USDA Forest Serv. Leaflet 143.)

Insects

Some of the following material may be found in local libraries or obtained from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Hay, C. V. and R. C. Morris
Carpenterworm - USDA Forest Pest Leaflet 64, 1970.

Wilson, L. F.
European Pine Sawfly - USDA Forest Pest Leaflet, 1971.

Wilson, L. F.
The Green-striped Mapleworm - USDA Forest Pest Leaflet 77, 1971.

Wilson, L. F.
The Red-headed Pine Sawfly - USDA Forest Pest Leaflet 14, 1970.

Wilson, L. F.
Variable Oak Leaf Caterpillar - USDA Forest Pest Leaflet 67, 1971.

Wilson, L. F.
Walkingstick - USDA Forest Pest Leaflet 82, 1971.

Herbicides

Converting Brushland to Pasture - MU Guide 4690

Woody Plant Control - MU Guide 4865

Know Your 2,4-D - MU Guide 4902

Guides are available at local Extension offices or from:

Publications
205 Whitten Hall
University of Missouri
Columbia, MO 65201